# GIS - RELATED EDUCATION AND TRAINING AT SIEMENS

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## ABSTRACT

With its wide range of various software modules SICAD has become a recognized and approved tool for the creation, maintenance, and extension of Geographic Information Systems. SICAD programs may run on microcomputer based graphic workstations in stand-alone mode as well as on large mainframes. The activities and facilities of the company to deliver the necessary education and training to the users of SICAD in order to enable them to master that tool are described. The important role played by the Siemens School for Data Processing and Communication Techniques in this regard is highlighted. The School's offer for professional training and education does not only comprise trainee programmes and courses for customers and Siemens staff. There are also courses held of up to two years that will lead to official qualifications and publicly recognized professional degrees. Efforts are also undertaken in the field of continuing education and re-education and training of the unemployed. The contributions of the company's consultants and site engineers towards education and training of the users by means of individual project support for GIS are mentioned. Finally, a brief outlook is given on the role of user groups, and perspectives on future strategies for education and training are outlined.

## INTRODUCTION

Siemens AG is among the World's biggest companies in the fields of electrical engineering and electronics. The company employs more than 320 000 people, the staff of its subsidiaries not included. The network of subsidiaries and branch offices spreads all over the world. One of the company's major activities is the development and manufacturing of a wide variety of computers and their related devices. They are marketed internationally together with the respective system software and numerous packages of applications software, many of them being original in-house developments.

It has always been company policy to offer and deliver far ranging support on the technical side during product installation and thereafter, as well as on the applications side, where experts are available, who are highly proficient in such fields as mechanical, electrical or civil engineering, statistics, surveying or cartography, to name here but a few. If so desired, support can be rendered during every stage of a

user-defined project, i.e. especially during planning, design and implementation. Thus, complete solutions for various complex problems can be offered: hardware and software, networking and personal project support all out of one hand. One such solution is put together under the name of SICAD-Cartography - SICAD standing for Siemens computer aided design. It comprises the full range of tools needed for the layout, implementation and maintenance of Geographical Information Systems (GIS).

In order to be able to realize the described concept of support in a most efficient manner, organized training and education became established practice right from the beginning of the production of computers at Siemens some 30 years ago. Consequently, most of the knowledge how to use SICAD for the creation and maintenance of GIS is transferred to the users by means of courses, hands-on sessions and seminars by the Siemens School for Data Processing and Communication Techniques. In the following, the SICAD-Cartography concept is explained in order to outline its scope and to understand its significance for GIS. Then, after a brief description of the organisation, structure and tasks of the School, it is shown how SICAD training fits in, and how it relates to GIS.

## SICAD-CARTOGRAPHY - TOOL KIT FOR GIS

The definitions given for GIS over the years are numerous. A concise and widely accepted one was given by (Bacon, Kanowitz 1986), when they referred to (Tomlinson's 1976) interpretation: Geographic information systems (GIS) are computerized systems designed to store, process and analyse land resource data sets. In this form, land information systems are GIS, too. Looking at the components of GIS makes it clear, why computer manufacturers and software developers should play a role in GIS training and education. According to (Burrough 1986), GIS have three important components:

- computer hardware,
- sets of application software modules,and
- a proper organisational context.

They need to be in balance, if the system is to function satisfactorily . The SICAD-Cartography concept provides the first two components in toto, and far reaching assistance can be rendered for the third one. Hardware and software have a modular structure. SICAD software may run on microcomputers as well as on large mainframes with many terminals. The range of graphics workstations offers a solution for virtually every professional user, pricewise as well. Workstations in the upper range are capable of a combination of vector and raster data processing, they give the choice of more than 16 mio different colours, are equipped with a 3D hardware segment, and can be upgraded by a powerful array processor. All workstations have SINIX processors of 4 Mbyte CPU or more. The smallest station has a 32 Mbyte hard disk, the biggest stand-alone can be upgraded to more than two Gbyte.

SICAD-DIGSY, a digitizing CAD package with special additional functions for surveyors and cartographers, can run on all of them. The operating system SINIX is a UNIX derivative. Image processing and the combination of vector and raster data is done with the help of SICAD-HYGRIS (hybrid graphics information system). The vector software of HYGRIS is the DIGSY package. From DIGSY, an interface exists to the other SICAD software, which is run under the Siemens operating system BS 2000.

For decentralized applications or for starters, the graphics workstation WS 2000 may be used as a stand-alone microcomputer under BS 2000 as well. All BS 2000 SICAD-modules, including the geographical data base and 3D terrain modelling, can run on this workstation in stand-alone mode. The WS 2000 has 8 Mbyte main memory, extendable to 16 and 32 Mbyte. A minimum of 255 Mbyte storage capacity is available on a fixed disk, and up to three disks at 600 Mbyte each may be added. It has its own graphics processor and an IOP of 4 Mbyte main memory. All workstations are available with a standard tablet of 1280x600 mm - 3xA2 - or an A3 tablet. The cross hair cursors have five (standard) or more function keys. Each workstation has a graphics and a b/w alphanumeric screen, where most of the dialog is run. The separate keyboard is available with various national lay-outs for the keys. The graphics screen has a raster refresh rate of 60 Hz, and a resolution of 1280 x 1024 pixels. 256 colours are standard. All sorts of non-exotic plotters may be connected, as well as matrix printers and a tape drive.

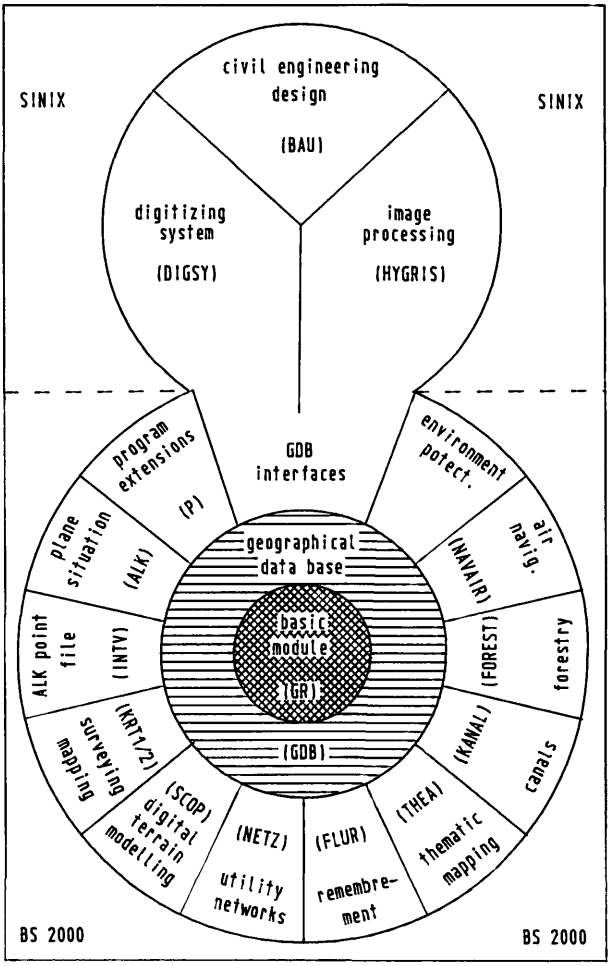
Applications with large area coverage often require outlets at several different sites. Furthermore, it can be an advantage to keep and administrate the data base centrally, e.g. for data security reasons, but have all outlets connected. A mainframe host connected with the graphic terminals via data transfer lines is here the solution. The workstations can have a double function as terminals and stand-alones. The usual transfer rates between 9.6 to 64 kbaud are used.

Whereas DIGSY, HYGRIS and the civil engineering, construction and design package SICAD-BAU are all entities on their own, the BS 2000 packages are all based on the SICAD-GR CAD module. The essential extension package for GIS is the geographic data base (GDB), an integration package that combines a geographical part for continuous maps at high accuracies with a conventional relational type data base for additional non-graphic information that may have a geographical bearing.

The diagram shows that the various software modules can cover a wide range of GIS applications. However, the system is open-ended: a user may write his own program extensions as well as procedures. Except for DIGSY and HYGRIS, which are run in menu mode, all modules are command orientated. A command may be followed by parameters and positions. Command sequences may be

written in procedure form. The user can write his own menus and run the system in menu mode. Five menus with more than 200 menu fields each, where each field may consist of more than 240 characters, can be activated at a time. The system can make use of layer techniques, and can store a geographical area, which may practically be of any size, provided there are enough disks for storage available.

So, SICAD has become a recognized and approved tool for GIS. SICAD systems can be found in many countries. SICAD dialog texts and user manuals are available in English and German. For certain users, text translations have been made into their home languages, e.g. for users in China. Publications about GIS with SICAD and experience gathered date back to the mid-eighties - e.g. (Schilcher 1985), (Vogel 1986) - and have not stopped to appear ever since.



## EDUCATION AND TRAINING BY THE SCHOOL

The Siemens School for Data Processing and Communication Techniques is located in Munich, West Germany. Its three main branches are: devices, systems, and professional education and training. Subordinate regional schools are situated in 16 other German towns, well distributed over the entire republic. Siemens subsidiaries in other countries often have their own training facilities, e.g. in Austria, Italy, Portugal, the UK to name here only a few. They are independent from the German School, although they require its services from time to time.

The School's total number of staff amounted to 524 in the past year with more than 330 lecturers, externals not included. The School is open for everybody. The lecturers are experts in their own fields, usually holding BSc, MSc, PhD or similar degrees. Their performance is permanently controlled, e.g. with the help of evaluation sheets each course participant is asked to fill in and hand back by the end of the course. The lecturers themselves undergo ongoing training. Their skills as educators and instructors must be proven, e.g. by qualifying before the examiners board of the public Chamber for Commerce and Industry. 500 different course modules are offered in 150 special rooms for lectures and practicals. 20 main frame computers with 1000 terminals and many PCs are available for those purposes. There were more than 71000 course participants last year, and the average number per course was 17.2. Course fees worth some US $ 80 mio were received. More than half of all participants' days were spent for courses for professional education and training, re-education and continuing education. Within the branch of professional education, trainee programmes, software development courses, leadership and working methodology, office organisation, expert systems, management seminars, and interactive teachware systems are covered. Many of the topics are manufacturer and product independent. Professional education on behalf of the public labour administration is offered in courses of up to 2 years. Programmers, operators, CAD-designers, CAE systems engineers and others may obtain their professional training and education at the School. More than 2000 candidates make use of that offer at one of the Siemens school sites each year.

The courses are recognized and approved by the public labour administration and are mainly directed towards re-education and continuing education. Many participants are unemployed academics, who can improve their chances for re-employment quite considerably. Such re-education measures are sponsored by the public labour administration. Other high-tec companies have similar schemes in Germany. At the end of the training, examinations have to be passed, and the successful candidates receive publicly recognized certificates about their new professional degrees.

There have also been such courses for people who wished to become CAD cartography designers. They were trained in the necessary background and systems knowledge, the use and application of the operating systems and the use of the hardware. Thereafter, they had to pass all the SICAD course modules in block form. Successful participants can find jobs within Siemens, or at users of GIS.

The compact courses for customers and Siemens staff members as offered by the systems branch of the School, may have even a greater impact on proper GIS training. Three types of courses are held there:
- Single courses for the different modules of SICAD and the acquisition of the necessary knowledge of the operating systems as quoted in the annual course schedule are one type. Target groups, prerequisites for the attendance, course contents and objectives are stated, as are the prices, places and times. 19 different courses are offered in four towns regularly. In a 2 days seminar management and interested parties are informed about the entire range of the SICAD product spectrum. In a full week, an introduction to the BS 2000 and SINIX operating systems is given. For all SICAD software modules single courses, each lasting between 3 and 7 days, are offered. For some modules more than one course is recommended, because of their complexity. Not all courses have to be attended for the various applications, but some 20 to 25 course days spread over a longer or shorter period are recommended, if the user wants to become proficient in the shortest possible time. The price for a 5 day course is less than the equivalent of US $ 2000.-, tax included.
- The second type are special courses, and block courses in particular. Mainly new SICAD users are addressed. In a very compact form, the participant is introduced into the system environment of SICAD, the use of the operating systems, and essential parts of the SICAD applications software. The block is split in two parts, the first consisting of up to 3 days instruction about the system environment, the use of the operating systems and the graphics workstations, 3 days SICAD-Basic module with the command structure, generation and manipulation commands, image handling, query commands, symbol and menu techniques. Another 2 days follow about the special SICAD procedure technique. SICAD procedure features have great similarity with the variables, arithmetic and logical functions, loops, subroutines and conditions of high level programming languages. Only the very essentials can therefore be taught during these 2 days. 1 to 2 days of instructions about the geographical part of the geographical data base follow. The participant learns how to set up the geographical boundaries for his GIS, how to create the continuous map, and how to achieve data security and define access rights. The first part of the block is concluded by a 4 day long instruction on the special survey and mapping extensions needed for GIS. The generation of special symbols for survey points, slopes etc., the standard survey calculations (polars, joins, area etc.), affine and

Helmert transformations with more than 40 redundant determinations and least squares adjustment, dimensioning, layer techniques, and last but not least the way how to create proper project plans for GIS are being dealt with. This first part comprises a total of 14 working days. As with the other SICAD courses, the mornings are usually reserved for a brief repetition of the previous day's topics, and then followed by theoretical instruction. In the afternoons, there is ample opportunity for all to do practical exercises on the graphics workstations, where usually no more than 3 share one workstation. The second part of the block will last 5 to 10 days, with a 5 day introduction into the handling of the non-graphics part of the geographic data base and the combination with the graphics at the beginning. The other 5 days are set aside for instructions about special applications, e.g. the package about the documentation of utility networks, the 3D digital terrain modelling, or thematic applications - all depending on customer request.
- The third type of courses are those being held on special user request . They usually take place on the user's premises. However, the user must have rooms for lecturing and a sufficient number of graphics workstations must be available on the site.

Block courses and special courses are offered in English and in German. They were held 5 times in 1988. Provided the participants are given sufficient time for practising right afterwards, those courses are the best way to learn as much as possible in the shortest time possible about the use of the tools for the GIS. A lecturer's day is then billed at something less than US $ 2000.- For big users who start their SICAD GIS, block and special courses are often the most favoured option for getting their staff acquainted and familiarized with the system.

In all SICAD courses reference is made to theoretical fundamentals and practical experience gained in GIS applications. There are also courses being held by university lecturers about general theories behind certain applications. The 5 day SICAD-BILD course about the theories of image processing is one of them. External experts from various fields of applications regularly hold courses and seminars for advanced users. Most of all courses are held on the School's premises in Munich. This is also the place where most of the SICAD program development is done.

User training is not over, once the respective courses have been attended. Siemens site engineers and consultants assist the customer in all stages. They may take part in the project meetings of the various GIS organisation and management groups, give advice in GIS design, organisation, and management aspects, if so desired. If specific know-how for certain side aspects cannot be found within the company, external consultants of renown in their own field, who often work already on a contractor's level for the company, will be called.

Many SICAD users have joined so-called user groups in several countries. They attend meetings held regularly, where experience and information is exchanged. Procedure packages developed by a user are made known to others, and might find interested parties who do not want to re-invent the wheel. Sometimes proposals for certain improvements or extensions of the GIS tools are formulated and submitted to the company. Such proposals are considered in version updates, if they are reasonable and meaningful. Established users sometimes are approached by the company to offer their knowledge gained in practical GIS applications to advanced users in special courses and seminars. Thus, a permanent flow and backfeed of information between supplier and users as well as in between the users themselves is a reality.

## CONCLUSION

In order to design, organize and manage a GIS effectively, it is imperative that the user masters the computer hard- and software components excellently. It has been found that intensive course training and continuing support in situ are most effective means to achieve these goals. For comprehensive, large areas covering GIS, a considerable amount of system knowledge - knowledge of the GIS tool kit - is necessary. There are maybe as many different approaches with different software and data structures as there are manufacturers of those systems. Version updates and new releases are still taking place at fast pace. Public institutions concerned with education and training will most probably not be able to invest the amounts necessary to keep abreast with the various developments of all different manufacturers at any time, and provide large area coverage for learners as well. Manufacturers, on the other hand, have the skilled staff to train others from first hand, with lecturers often being involved directly in the respective developments, or having a hot line to the development section of the company. Close cooperation between public institutions concerned with teaching the theories and skills needed for GIS handling and the various manufacturers might become more and more important in the future. Manufacturers cannot and will not take over the role played by independent institutions of the public concerned with teaching - such as universities, technicons, technical high schools and others. But further improvement of the cooperation would certainly be beneficial to users, independent public educational institutions and manufacturers as well.

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